

## CLAIMS

What is claimed is:

1. An emulator for use in digital communication design, optimization, and validation comprising:

a transmitter impairments emulation;

a transmitter interface;

a receiver impairments emulation; and

a receiver interface.

2. An emulator for modeling a plurality of signal impairments which manifest themselves onto a communication data signal between modulation and demodulation in a communication system, the emulator comprising:

a plurality of programmable transmit modules emulating a plurality of signal impairments that occur during communication media modulation, each said transmit module having a signal input for coupling with a transmit modem, an output and a communication bus coupling;

a plurality of programmable receive modules emulating a plurality of signal impairments that occur during communication media demodulation, each said receive module having a signal input, an output for coupling with a receive modem and a communication bus coupling;

a user interface communicating with a processor for defining a communication system simulation by soft coupling a required number of said transmit and receive modules in a user defined simulation arrangement using said transmit module outputs and said receive module inputs; and

said processor instructing each of said required modules via a communication bus to use specific signal impairments from said plurality of respective signal impairments for said user defined simulation arrangement.

3. The emulator according to claim 2 wherein said plurality of transmit module impairments further comprise linear impairments.

4. The emulator according to claim 3 wherein said transmit module linear impairments further comprise:

amplitude imbalance;  
bandwidth group delay;  
bandwidth limitations;  
carrier frequency offset;  
carrier leakage;  
carrier phase imbalance;  
carrier phase noise;  
carrier phase offset  
modem noise; and  
transmitter noise.

5. The emulator according to claim 4 wherein said plurality of transmit module impairments further comprise non-linear impairments.

6. The emulator according to claim 5 wherein said transmit module non-linear impairments further comprise:

amplitude modulation to amplitude modulation; and  
amplitude modulation to phase modulation.

7. The emulator according to claim 6 wherein said plurality of receive module impairments further comprise linear impairments.

8. The emulator according to claim 7 wherein said receive module linear impairments further comprise:

amplitude imbalance;  
bandwidth group delay;  
bandwidth limitations;  
carrier frequency offset;  
carrier dc offset;  
carrier phase imbalance;  
carrier phase noise;  
carrier phase offset  
modem noise; and  
receiver noise.

9. The emulator according to claim 8 wherein said plurality of receive module impairments further comprise non-linear impairments.

10. The emulator according to claim 9 wherein said receive module non-linear impairments further comprise:

amplitude modulation to amplitude modulation; and  
amplitude modulation to phase modulation.

11. The emulator according to claim 10 further comprising a plurality of programmable media modules emulating a plurality of signal impairments that occur during signal transmission through a communication channel media, each said media module having a signal input for coupling with the output of a transmit module, a signal output for coupling with the input of a receive module and a communication bus coupling for coupling with said communication bus.

12. The emulator according to claim 11 wherein said media module emulates guided and unguided communication channel media impairments.

13. The emulator according to claim 12 wherein said guided media impairments comprise attenuation and delay.

14. The emulator according to claim 13 wherein said unguided media impairments comprise value fluctuation, location characteristics and distance characteristics.

15. An emulator for modeling at least one signal impairment which is manifest onto a communication data signal between modulation and demodulation in a communication system, the emulator comprising:

at least one programmable transmit module emulating at least one signal impairment that occurs during communication media modulation, said at least one transmit module having a signal input for coupling with a transmit modem, an output and a processor interface;

at least one programmable receive module emulating at least one signal impairment that occurs during communication media demodulation, said at least one receive module having a signal input, an output for coupling with a receive modem and a processor interface; and

a processor, with associated memory, for configuring said transmit and receive modules via selected characteristics stored in memory.

16. The emulator of claim 15 wherein said at least one transmit module impairment emulates a dynamic impairment.

17. The emulator of claim 16 wherein said dynamic impairment comprises at least one of the following of sine waveform; swept sine waveform; square waveform; sawtooth waveform; or impulse waveform.

18. The emulator of claim 15 wherein said at least one receive module emulates a dynamic impairment.

19. The emulator of claim 18 wherein said dynamic impairment comprises at least one of the following of sine waveform; swept sine waveform; square waveform; sawtooth waveform; or impulse waveform.

20. The emulator of claim 15 further comprising at least one programmable media module emulating at least one signal impairments that occur during signal transmission through a communication channel media, each said media module having a signal input for coupling with the output of a transmit module, a signal output for coupling with the input of a receive module and a processor interface.

21. The emulator of claim 15 wherein said at least one transmit module impairment further comprises a linear impairment.

22. The emulator according to claim 16 wherein said transmit module linear impairments further comprise at least one of the following of amplitude imbalance; bandwidth group delay; bandwidth limitations; carrier frequency offset; carrier leakage; carrier phase imbalance; carrier phase noise; carrier phase offset; modem noise; or transmitter noise.